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Studies on Applicability of Pervious Concrete for Pavements

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Abstract-- **The concrete technology has made remarkable progress in past decades. Among several types of concrete such as high performance concrete, self compacting concrete, light weight concrete, etc. pervious concrete plays a different role which is an exceptional case. The principle reason to develop this type of concrete is to use this concrete for pavements, open floors, etc since rain water may pass through it and increase the ground water table. The paper determines the possibility of achieving maximum compression strength and permeability in concrete by replacing fine aggregate with coarse aggregate and cement along with the addition of admixture in order to increase the permeability of concrete. [1] In this study, the pervious concrete is obtained by removing the fine aggregate wholly (0%) and partially as 10% and 20% replacing the coarse aggregate.**

Keywords: **concrete technology, light weight concrete, compression strength coarse aggregate.**

I. INTRODUCTION

The concrete technology has made tremendous strides in past decade. Concrete is now no longer a material consisting of cement, aggregate, water and admixtures but it is an engineered material with several new constituents. The concrete today can take care of any specific requirement under most of different exposure conditions. The concrete today is tailor made for specific applications and it contains several different materials. [2,5]

Pervious concrete is a special type of concrete with a high porosity used for concrete flatwork applications that allows water from precipitation and other sources to pass directly through, thereby reducing the runoff from a site and allowing groundwater recharge. Pervious concrete is traditionally used in parking areas with light traffic, residential streets, pedestrian walkways, and greenhouses.

II. CONSTRUCTION TECHNIQUES

An experienced installer is vital to the success of pervious concrete pavements. As with any concrete pavement, proper sub grade preparation is important. The sub grade should be properly compacted to provide a uniform and stable surface. When pervious pavement is placed directly on sandy or gravelly soils it is recommended to compact the sub grade to 92 to 96% of the maximum density. Typically pervious concrete has water to Cementations Materials (w/cm) ratio of 0.28 to 0.40 with a void content of 15 to 25%.

A properly proportioned mixture gives the mixture a wet -metallic appearance or sheen.

Curing should begin within 20 minutes of concrete discharge and continue through 7 days. Plastic sheeting is the standard method of curing, however, this contributes to a substantial amount of waste sent to landfills [3].

III. EXPERIMENTAL APPARATUS AND MATERIALS REQUIRED

Ordinary Portland Cement (C 53 grade) conforming to the requirements of IS 12269 (ASTM C 150-85A) was used in the study. Natural river sand was used as fine aggregate and crushed angular granite stone was used as coarse aggregate. Coarse aggregate with combined grading of 50% passing through 20mm sieve and retained on 12.5mm and 50% passing through 12.5mm and retained on 4.75mm sieve conforming to IRC 44 was adopted.

3.1 Mix Proportioning

An experimental programme was chosen with cement contents 300, 375 and 450 kg/m³ being the practical range considered for normal concrete and that of water is fixed between 90 to 130lt/m³ based on the field information published in the literature[6]. The water/cement ratio ranges from 0.21 to 0.43 and that of volume of paste (volume of cement and water) from 0.19 to 0.27.

3.2 Method Of Mixing And Compaction

Mixing was done using a pan mixer. Initially the dry mix constituents of the mix namely cement, fine aggregate and coarse aggregate was mixed for two minutes and then the water with chemical admixtures. The total mixing time was kept at 4 minutes for all the trials until a homogeneous mixture was obtained.

3.3 Specimens

Cubes of size 150mm were cast and tested for compressive strength at the age of 7 and 28 days and beams of size 150×150×170mm at 28 days for flexural strength as per IS 516. Cylinders of 150×300mm were cast and tested at 28 days for co-efficient of permeability by constant head. All the specimens were kept immersed in water until the time of testing.

3.4 Preparation Of Concrete

Production of quality concrete requires meticulous care exercised at every stage of manufacture of concrete.

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Therefore it is necessary to know the good rules to follow in each stage of manufacture of concrete for producing good quality concrete [5].

3.5 Water Curing

This is by far the test method of curing as it satisfies all the requirement of curing namely promotion of hydration, elimination of shrinkage and adsorption of the heat of hydration.

3.6 Preparation Of Specimens For Testing

The specimens were taken out from the curing tank on the testing day to prepare them for testing surface water and grit taken wiped off to and allowed to dry for about one hour. The specimens were marked accordingly to their respective mixes [3,5].

IV. TEST ON FRESH CONCRETE

4.1 Slump Test

Dampen the slump test mould and place it on a flat, moist, nonabsorbent, rigid surface, like a steel plate. Fill the mould to 1/3 full by volume (about 21/2 inches), and rod the bottom layer with 25 evenly spaced strokes. Fill the mould to 2/3 full (about 6 inches), and rod the second layer with 25 strokes penetrating the top of the bottom layer. Strike off the top surface of the concrete even to the top of the mould. Remove the mould carefully in the vertical direction (take about five seconds).[2] Immediately invert and place the beside the slumped concrete and place the rod horizontally across the mould, and measure the slump, in inches, to the nearest ¼ inch. The slump test should take approximately 21/2 minutes.

V. TEST ON HARDENED CONCRETE

Testing of hardened concrete play an important role in controlling and confirming the quality of cement concrete works. Systematic testing of raw material fresh concrete and hardened are inseparable part of any concrete with regard to both strength and durability the test methods should be simple, direct convenient to apply one of the purpose of testing hardened concrete used at side has developed the required strength.

5.1 Compressive Strength Test

Compressive strength is one of the important properties of concrete. Concrete cube of 150×150×150mm were cast. After 24 hours the specimen were remolded and subjected to water curing. After 7, 14, 28 days of curing of 45 cubes were taken and tested in compression testing machine [7]. The cube specimen is of the size 150mm×150mm. if the largest nominal size of the aggregate does not exceed 20mm, 100mm size cubes may also be used as an alternative.

Compressive strength=load/area=P/bd in our investigation, we used 150mm ×150mm×150mm size cube. The compressive strength of pervious concrete for 7,14, and 28 days are calculated and tabulated.

5.2 Flexural Strength Test

Tests were carried out conforming to IS 516 (1959) to obtain the flexural strength of various concrete mixtures. Fifteen beams of size 100mm×100mm×500mm were tested. The beams were tested using two points loading. The experimental results of flexural strength are shown. The mixes M1, M2, M3, M4 and M5 were tested at 7, 14 and 28 days of curing and various results

$$F_b = P \times L / b \times d^2$$

When a is greater than 20cm for 15cm specimen or greater than 13.3cm for 10cm specimen,

Where,

P=maximum load in Newton applied to the specimen
L=supported length in mm
d=depth of specimen in mm
b=width of specimen in mm
a=distance of crack from the nearest support

If a is less than 17cm for a 15cm specimen, or less than 11cm for a 10cm specimen the result of the test is discarded. As the mentioned earlier, it is difficult to measure the tensile strength of concrete directly of late some methods have been used with help of epoxy bonded end pieces to facilitated direct pulling.

VI. RESULT AND DISCUSSION

6.1 Compressive Strength Test

TABLE. 1
COMPRESSIVE STRENGTH OF PERVIOUS CONCRETE AT 7 DAYS

MIXES	Trial 1	Trial 2	Trial 3	Average
M1	7.10	7.10	8.00	7.40
M2	8.00	8.40	8.20	8.20
M3	11.80	12.00	12.13	12.64

From the above results, we came to know that, the mix M3 with 20% fine aggregate yields good compressive strength and flexural strength. The permeability rate is higher for mix M1 with 0% fine aggregate. The mix M2 with 10% fine aggregate yields good compressive strength and flexural strength.

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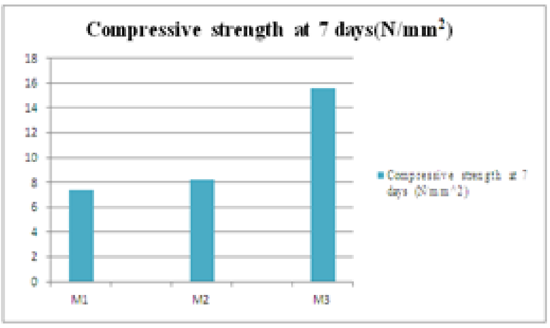

Figure 2 . Compressive Strength of Pervious Concrete at 28 days

6.2 Sorptivity Test

Table. 2
Sorptivity Test For Mix M1

Q (cm)	√t (√s)
0.36	5.47
0.80	9.49
0.98	12.25

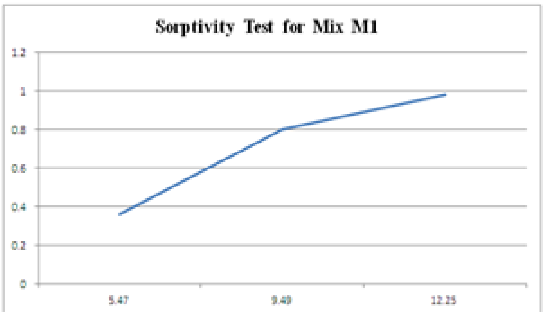

Figure. 2 Sorptivity test for Mix M1

VII. CONCLUSION

Although limited in its applications, pervious concrete has the potential to help mitigate many of the urban storm water quality issues one of the objectives of this research was to develop a preliminary pervious concrete specification for Maryland conditions. Several admixtures have been tested as part of this research with the objective of increasing strength, durability and workability of pervious concrete.

Improved strength, durability and workability would lead to a wider application of pervious concrete.

The types of admixtures that were tested as part of this research included delayed set modifier, viscosity modifier, and cellulose fibers. The ability to discharge, place, and finish pervious concrete within a relatively short time span is a major concern for concrete producers. The relatively short working time window with pervious concrete often leads to a very fast paced, labor intensive effort. Incorporating a delayed set modifying admixture into the pervious concrete mix design inevitably allows a longer working window for placement [2,4].

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